Paper/Work

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LAWRENCE LIVERMORE POSTDOC ASSOCIATION

POSTDOC ASSOCIATION INTERVIEW WITH DR. ED MOSES

Dr. Ed Moses is the Principal Associate Director of the National Ignition Facility and Photon Science Directorate (NIF & PS). He has been instrumental in creating NIF, the world's largest laser, and keeping LLNL the world leader in high energy density science research.

Ed met with the Postdoc Association for the fascinating and informative discussion that we present here. David Martinez, David Alessi, Charles Reid, and Nathan Kugland conducted the following interview on August 23, 2012.

David Alessi: Tell us how you got to the Lab.

Ed Moses: When I was in graduate school at Cornell, I was working on laser research that has pretty much passed into oblivion: tunable dye lasers. I was doing both narrow-band and short pulse dye lasers back when picoseconds were as short a pulse as you could get. After finishing, I went to Hughes Aircraft in Los Angeles — quite a change from Ithaca, NY. Ironically, I was working on a project for the Lab on high-average power frequency doubled Nd:YAG lasers. The goal was to increase the average power capability of this laser by a factor of 100 from less than 1 watt to nearly 100 watts. The Lab wouldn't tell me what it was for but I slowly figured out that the Lab was looking forward to thousands of watts, and they did tell me it was to pump dye lasers, so I really started to think about how to do that. Then Mary Spaeth, who later became my mentor, and who later became the chief scientist at NIF, came down to see what I was doing. She invited me to come to the Lab and give a talk. That was in 1979, the first time that I came to the Lab, and I didn't know it was a job interview (this was the old Lab, where they didn't volunteer information). So I gave my talk that was essentially: "Here's what I think you want, and here's how I would do it." I presented an architecture for a multi-kW dye laser system capable of operating in multiple colors simultaneously. After the talk Mary took me back to her office and said, "Here's the deal. We're going to offer you a job and it will be a good offer. Or, we're going to cancel your contract, take your notes, and you'll never speak about this again." So that's how I came to the Lab: I took an offer that I couldn't refuse and I never looked back.

David Alessi: What are some of the habits that have made you a successful person, and what habits would you advise postdocs to pick up?

Ed: Well, I don't know exactly what a successful person is, but I do know that the most important "good" habit is that I study hard when I'm working on any problem, and I try to become as knowledgeable as possible on as many things as I can. That way, I can make good judgments about what the team is doing and provide benefit to our work. I also try to always keep in mind that every assumption I have is wrong, and it is very likely that I don't even know that I have it. You should always re-think the problems that you're working on with that in mind. If you do that, you can make yourself and your teammates better. We all tend to Groupthink - it is our natural tendency. We may make fun of sheep, but in the end, we tend to be sheep. Great scientists and great engineers are the ones who see that what everyone else is talking about is often just wrong, sometimes big time wrong and sometimes subtly. They may not see exactly what is right, but they can see the hidden seam in the problem—the place where new solutions and approaches exist. If you look at every great scientist, they changed the questions that were being asked and they changed the way people were thinking. I always try to keep this paradigm in mind.

Charles Reid: A lot of Big Science projects are really sexy, and easy to get people interested in them: the Hubble space telescope, that's creating all of these beautiful images, or the Mars Rover, which is a nuclear-powered car landing on another planet. What is special about it?

Ed: When I think about Big Science, I think about it slightly differently. Why does anyone care about the Hubble? It's taking pictures of places that humankind will likely never visit. So, what's so exciting about that? It's exploration. We're just genetically programmed to explore. I think one day, somebody will find that part of the genome, and we'll be able to say, that's what makes us different—that is the innovation/exploration gene, the *curious* gene. I think the whole issue with Big Science is: why does it get going at all? Why does anyone care

about the Higgs boson? Why pump billions of dollars into finding some quantum mechanical entity that arose out of the Big Bang that gives the universe massive particles? Why build the great telescopes and why build the NIF?

I think that the answer is that they are so intriguing, and also so threatening. It's intriguing to our gene set, and yet it's so threatening to the established power structure.

When I think about NIF, what's so interesting about it is that you can stare out into the cosmos by looking into targets at the center of the target chamber. It can change your view of the world forever. We are doing our mission: ensuring strategic security without testing, being able to create the universe in a little gold can, and unleashing the clean, carbon-free energy of fusion.

Charles Reid: Speaking of energy, it seems like getting people excited about energy, how a light bulb turns on, is harder. How can we get people interested in, or excited about, solving energy problems?

Ed: Right, clean energy is a very interesting example. People don't know what to do about it because they see it as an overwhelming problem. I don't think that they feel that they have a play in the game and their near-term motivations are not consistent with the long-term consequences. People who don't have energy want it, and they are not concerned about the downsides of getting it. That is the conundrum of this great human societal challenge. The immediate demand for more energy is being satisfied almost exclusively by carbon-based sources such as coal. The time scale during which the negative effects of carbon-based energy will become obvious to all is long. The alternatives to carbon are generally expensive or not easily applicable to base load energy. It's hard for us to imagine what to do when there are no obvious solutions.

And that's where the Laser Inertial Fusion Energy (LIFE) project comes in. When I talk to people about LIFE, many are totally turned on to it. I show them LIFE targets and say: "In each of these peppercorn-sized targets is 40 kWh of electricity. The only byproduct is helium. The hydrogen in a few hundred gallons of water will run a city of a million for a year." The level of interest is broad and deep. Environmentalists, utility executives, agribusiness for water desalination, and many others are showing positive interest. Many major power industry and technology manufactures have come to see us to discuss partnering opportunities. There are many discussions on structuring rollout strategies over the next 20 years and beyond. But just as LIFE is very intriguing and exciting, it is also very threatening to many in the science community who see laser fusion energy as too risky and not proven. They express skepticism: "It couldn't possibly be right," "You're over-promising," and the like. But this is not the issue for me. People have been saying the same thing about every laser we have built at the Lab, about the supercomputer programs and many of the innovations that make the Lab the great place it is. We have to always make sure that we are true to the laws of science but open to the possibilities of human innovation.

Charles: You mentioned that there's this feeling of impotence, that people don't have a play in the game. There's a grassroots movement in science called "citizen science" that comes out of things like the ham radio, but it's gotten bigger now. People can build weather stations that tweet the weather, or buy microcontrollers online and build their own robots, or put cellphones into rockets and send them into the upper atmosphere. How do you think citizen science can complement big science, and vice-versa?

Ed: I don't think citizen science is that new. In the old days, all science was citizen science — the great scientists like Galileo, Newton, and their like were all citizen scientists mainly working without support. A great many of us grew up as *children* citizen scientists, but it is way different and certainly more sophisticated now. When I was a kid, we called citizen science just "fun." We did all kinds of stuff with our chemistry sets and Heathkits. A generation later people were building simple computers and now there is capability to be a citizen scientist, doing sophisticated work that could not have been imagined before. What's different now is you have bandwidth that in the past we couldn't imagine. Citizen science projects are using mobile phones and consumer electronic recording capabilities for easy data collection. iPhone and Droid apps are used for monitoring wildlife, traffic, and meteors and are at the heart of the search for extraterrestrial intelligence. You

can share your work on YouTube or on social networks and other people can participate in your event or you in theirs. The value of this is participation and exponentiation of knowledge and awareness. It kick-starts the future and who knows where this can take us. It's very fractal to me. I think citizen science is making people look in awe at the universe we live in.

Charles: Do you think it can move beyond just being a motivator? Could it reach a point where citizen scientists could create useful data sets?

Ed: Sure. I was in Hawaii with Professor Bob Byer of Stanford and he has a 30 cm telescope with diagnostics that are commercially available. He can do astronomy as a citizen scientist that far exceeds what any professional astronomer on the biggest telescopes could do 30 years ago. It'll just keep getting better and better.

David M: NIF "grew up" at the same time that the Internet was "growing up." How do you think NIF would have been built differently if it had been built at a time that the Internet was already a mature technology, or if the Internet did not exist?

Ed: I don't know how much it has to do with the Internet, but the next NIF would be unrecognizable. Right now NIF is like "tube" technology: electricity off the grid is converted to white light using flash tubes that pump a quantum-mechanical system (laser amplifier glass). It's beautiful and will remain the state-of-the-art for years to come, but the technology is already passé. Today we would use efficient laser diodes for pumping the laser and the length of the laser beam line would go from over 120 meters long to about 10 meters long. This is a comparable length ratio to a tube TV turning into a flat-panel TV. But there is much more. The electrical to optical efficiency would go from less than 1% to over 15% and the laser firing rate would go from once every 10,000 seconds, to over 10 times per second. This is what LIFE technology would enable. One of the exciting concepts, the laser diodes, was invented at the Lab in the 90s. The optics we have today are so fundamentally different from the optics that we started with. These are also derivative from the great work we have done at the Lab on the NIF.

Charles: The question was also about communication. For example, during the Manhattan Project, the means of communication were limited. You had to be in the same room with someone to work things out. You had to have chalkboards and paper. Now, you can use technologies like tablet computers.

Ed: That's harder to evaluate. Since we always live in an ever-changing environment, and we always try to stay close to the state-of-the-art, it's hard to say how people would do it now. I'll say that much of Lab culture is a little behind on collaborative work environments and technologies. The Lab is pretty office-oriented and much of the Lab has to deal with classified work environments that require more control of work and communications than others may have to deal with. Architecture really defines behavior—how we sit and how we think really influence each other. Although we grew out of the paradigm of locked doors, safes, isolated networks, and so on, there is motion to change this in situations where this is possible. At the NIF and in other places around the Lab the slope is in that direction.

Nathan Kugland: There are definitely cultural differences between the Lab and typical high-tech companies in Silicon Valley.

Ed: Yes there are some very different strategies and cultures. But many of them are not so different. One of the most important parts of the Lab is that it is geographically close packed. All the staff is generally within a half-mile of each other—a mile at most. This leads to reasonably tight communication among us, much like Silicon Valley companies. Likewise, the Lab is very multidisciplinary which is what made Silicon Valley the innovation center that it is. Thirdly, the Lab and Silicon Valley both reward innovation and bold thoughts.

But there are two things that are most different between the Valley and the Lab. The Lab will take on projects that no one in private industry can imagine and the Lab has always had a commitment to a life-long relationship with its employees. This has been the magnet that keeps great people hard at work creating for the future and for the country and humankind. These two principles are what we have to keep in mind when planning our futures.

David A: What's your elevator speech for NIF? Who do you give it to?

Ed: An elevator speech, for those who don't know, is the jargon for the situation where you only have 30 seconds to say it all. For NIF it is simple—"To go boldly where no one has gone before. We use the power of light to do strategic security, energy security, frontier science, and competitiveness. The last century was the century of electrons; I believe that this century will be the century of photons and my goal is that the projects and research in NIF & PS will be remembered as making revolutionary steps along the way."

One thing that I warn you is that you have to remember that there is not one elevator speech. I give different versions of my elevator speech to different people all the time. An elevator speech is designed for the audience, not the elevator. A single speech will not serve you well. Every audience has a theme that they want to hear, and that they can hear. If you talk to them in a language other than what they are used to, they cannot understand your message. Scientists and engineers are often oblivious to this and they always assume that people know what they are talking about. You see professors who give less than stellar lectures even though they are clearly world leaders in their topics: they're talking to themselves and they don't even know it. To be effective you must show respect for your audience. Knowing who your audience is can be difficult. Scientists sometimes worry they will look less capable if they speak too simply and so they speak at a level that is comfortable for them but uncomfortable for the audience. My view is that you cannot talk down to an audience — you should speak with them.

Charles Reid: The National Ignition Campaign will be wrapping up at the end of this fiscal year, on September 30. What does the end of the National Ignition Campaign mean for NIF?

Ed: First we should define what the National Ignition Campaign is. The NIC is a six-year Congressional line item that has several goals. One of its goals was to convert the NIF from a construction project to a world-class experimental facility by installing diagnostics and cryogenics, safety systems and operational capabilities. The second goal was to demonstrate experimental capabilities in High Energy Density Science for the Stockpile Stewardship Program (SSP), for Inertial Confinement Fusion, for basic science and for other national security applications. It has been very successful in all of these areas, making discoveries in science. The third goal is to demonstrate fusion with gain, often known as fusion burn. And we have made great progress on this most challenging of our endeavors. This is a journey that we have been on for over 50 years. I have confidence that we have the tools and team to make this all happen.

So, when people ask me what will happen to NIF at the end of NIC, the answer is "everything will happen." We look forward to many years of operation executing all four missions and more.

Charles: Do you think that the upcoming national elections will have any implications for NIF, especially since they are coming so close to the end of NIC?

Ed: Well you can never predict the future, but NIF has been here through the terms of several presidents and multiple congresses. So far, the country has continually supported our work. Hopefully that is because our efforts and our mission transcend politics and serve the greater needs of our nation. That's really a statement about NIF and its staff and the Lab. Every year the country tells us to keep up the good work.

David M: Where do you see the NIF program 5 to 10 years down the road?

Ed: I see it continuing as an international center for high energy density science, with a much larger community of researchers who are really taking advantage of its frontier science capabilities. I see it having mature diagnostic capabilities, more energy, and more sophisticated experimental platforms. I see the interaction of exaflop computers opening up new experimental frontiers that we cannot imagine now. I hope we will have cleaned up many of the problems of the SSP program. I'd really like for someone to use the

POSTDOC ASSOCIATION INTERVIEW, CONTINUED

NIF to earn a Nobel Prize and, of course, I would like to have fusion energy as a reality.

David M: What is the status of the LIFE project? What are the challenges that it is facing?

Ed: Every project needs three things: clients, investors, and great people to plan and execute the work. That translates into needing a mission, needing money, and needing capabilities. NIF's mission was originally stockpile stewardship, but it always had basic science and fusion energy as key parts of its future. Our client is the American people and their surrogate is the Congress. For LIFE, the client is all of us and our surrogate for energy production is the utilities and others want to participate. There seem to be a lot of people interested in investing in LIFE. We're already on a roll, and people are already taking us seriously, but once we achieve ignition they will take us even more seriously.

Charles: You have quite a diverse bookshelf. Can you tell us about the last really interesting book you read?

Ed: Right now I'm reading a book, *The Creative Priority*, by Nissan's chief designer, Jerry Hirschberg, who transformed Nissan from a company that was revitalized using organizational techniques to reward creativity. The reason I'm reading this because it is about how structures in organizations define their output. Here Hirschberg talks about taking on the hierarchical Japanese ethos and make it work in a creative environment. But I also like science fiction—I still like Heinlein and authors like that, even though they were products of their times, in terms of their views on race and gender. Even their futuristic novels feel like the 1950's.

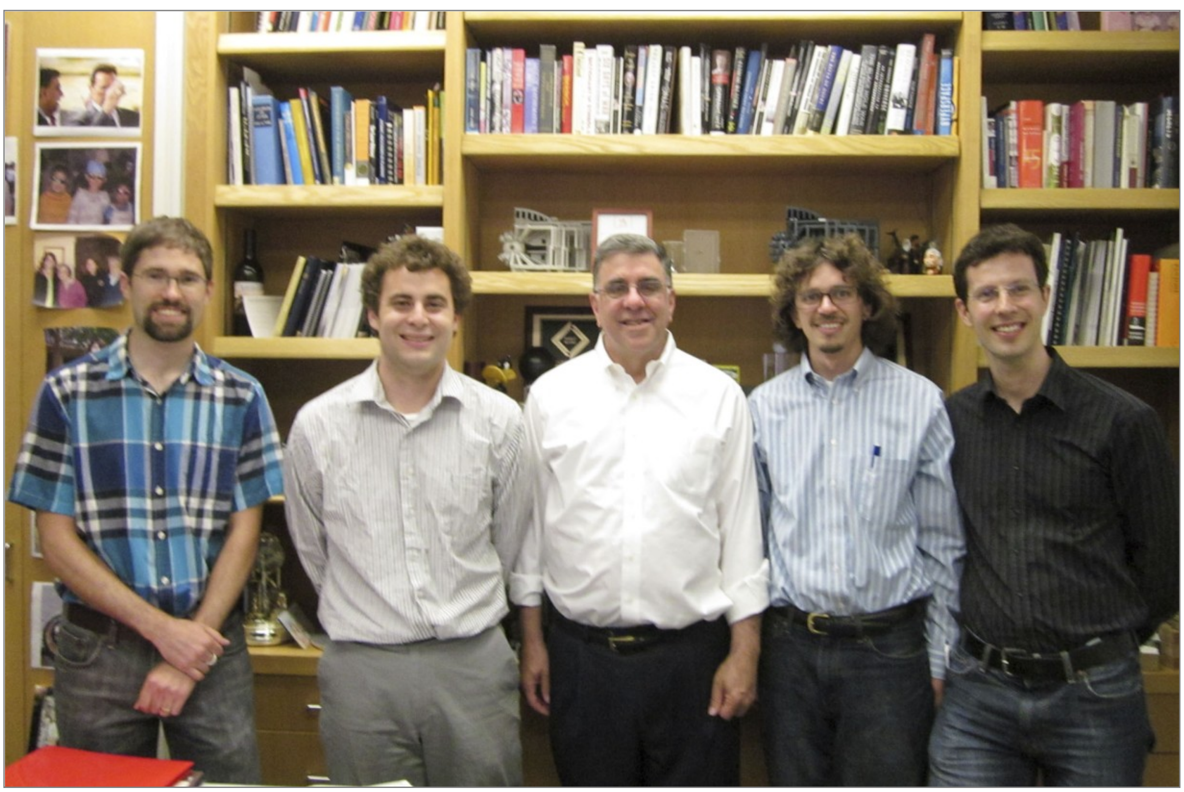
David M: Were any NIF employees used as extras in the filming of the new Star Trek movie?

Ed: Yes! Several people were in many scenes as extras. But, I think that most important part of the Star Trek experience was how we managed the interactions of 400 people from offsite in our facilities without any safety problems and with great esprit de corp.

David M: What advice do you have for young researchers at the Lab?

Ed: I think that the most important goal of young researchers is to develop themselves as fully as possible in their fields and to interact with as many people as possible in the Lab and in professional societies. There are opportunities to do this at the Lab and I ask you to make sure you take full advantage of them.

Thank you, Dr. Moses.



CAREER RESOURCES

UPCOMING EVENTS

PLS Postdoc Seminar Series
Tues, September 18, 11 am – 12 pm
B151 R1209 (Stevenson Room)
Sabrina Nagel (Physics) and Julia Vogel (Physics)

LLNL Family Days Open House
October 13-14
Celebrate the 60th anniversary of the lab with family and network with your colleagues! Register and get more information here.

ACADEMIC TEACHING PANEL

By Charles Reid and Nick Be

On August 14th, the IPPB hosted a discussion on careers teaching in academia. The participants included Korin Wheeler, Assistant Professor of Chemistry at Santa Clara University, Evan Reed, Assistant Professor of Materials Science and Engineering at Stanford, and Robert Herring, Adjunct Professor of Biomedical, Chemical, and Materials Engineering at San Jose State.

During introductions, Dr. Wheeler stated that she focused on teaching early in her career, taking opportunities to gain teaching experience during her postdoc. Dr. Reed, on the other hand, was a postdoc and staff member at LLNL before ultimately leaving for Stanford. When offered the position, he saw it as a research opportunity, but now views teaching as one of the highlights of his job. Dr. Herring began his career with a Ph.D. at Northwestern, followed by materials science work in military and industry environments, and was ultimately offered a position at SJSU, where he teaches undergraduate courses.

The panelists tackled many interesting questions from the audience. One consistent theme was that vast teaching experience is not necessarily a prerequisite for a teaching position – passion for the subject and material is more important. When pursuing a teaching position, you will be judged more by your ability to talk enthusiastically about your research. Interestingly, Dr. Reed stated that hiring committees primarily viewed him as an academic after his time at LLNL.

Teaching panel (cont):

The panelists also discussed navigating the tenure process, and how the first year is very chaotic, with many new responsibilities. Each received a startup package, which should be used to tap into the strengths of the university. They warned that the first few years will not include a great deal of work-life balance, which is why self-driven enthusiasm is so important. One interesting note was that Stanford allows one extra year in the tenure process for each dependent child (up to 4).

One of the common perceptions of academia is that it provides a great deal of independence; the panelists saw this as both true and false. While you may be free to pursue many different grant opportunities, you are expected to establish yourself as a leader in one specific area, which requires a great deal of focus. Balancing these pursuits with teaching requirements throughout the year is one of the challenges of academia.

For those interested in gaining teaching experience positions while at LLNL, adjunct opportunities can certainly be explored, but requests should be made through your leadership and official channels.

"Try new things. Be adventurous. It is OK, and certainly a lot of fun, to be evolutionary. There is no 'right' path for a Ph.D., only the right path for you."
-Laurel Haak, Ph.D.
Career Q&A

Job interviews at IKEA:

From: Interview lessons from an IKEA cartoon

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Computation:CASC: **Abhinav Bhatele**, Todd Gamblin, Katherine E. Isaacs, Brian T. N. Gunney, Martin Schulz, Peer-Timo Bremer, Bernd Hamann, "Novel views of performance data to analyze large-scale adaptive applications," Proceedings of ACM/IEEE International Conf. for High Performance Computing, Networking, Storage and Analysis (Supercomputing), 2012. LLNL-CONF-554552. http://sc12.supercomputing.org/schedule/event_detail.php?evid=pap537

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